

# Explaining large euro effects on trade: the extensive margin and vertical specialization

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## Abstract

We estimate that the euro has increased trade within the eurozone by about 26 percent and trade between the eurozone and outsiders by about 12 percent for the years 2002-2005 on average as compared to 1995-1998. The percentage increases were smaller for products that were exported every year during the sample period than for products that were not, indicating significant and substantial effects on the extensive margin of trade. The euro effects were concentrated to semi-finished and finished products, in particular to industries with highly processed products such as pharmaceuticals and machinery, indicating increased international vertical specialization.

Keywords: trade, euro effects, extensive margin, vertical specialization

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## 1. Introduction

The creation of the European currency union is the latest step taken by the European Union to increase economic integration between member states.<sup>1</sup> Economic integration is, in turn, motivated by the supreme goal of increased political integration. In view of the high political and economic stakes involved, it is of great importance to evaluate the effects of the European currency union on trade. Our paper is part of a small but growing literature that does so directly using data generated in the wake of the European currency union. It contributes to this literature by providing estimates of the euro's effects on trade for a considerably longer period of the euro's existence than in earlier studies and by providing evidence that the surprisingly large effects of the euro to some extent can be attributed to increased trade on the extensive margin and increased international vertical specialization.

Before economists began to study the effects of the European and other currency unions on trade, the general consensus among academic economists based on a considerable number of empirical studies was that nominal exchange rate uncertainty has very small or no effects on trade.<sup>2</sup> The first to study the effects of currency unions on trade – where nominal exchange rate uncertainty has been eliminated between members – was Rose (2000). He employed the gravity model of bilateral trade and pooled cross-section data on all existing currency unions to estimate that a common currency raises trade by 235 percent. A later study by Rose (2001) using panel data that include the formation and dissolution of currency unions since 1948 arrived at even higher estimates.

The first of a growing number of studies using data for the European currency union to estimate the euro's effect on trade was Micco, Stein and Ordoñez (2003). This literature has recently been surveyed and critically examined by Baldwin (2006a, b). He argues that estimates by Rose and others largely based on non-European data are driven by countries with peculiar characteristics (“very small, very poor and very open”), are fraught with methodological deficiencies and cannot be used to infer effects of the

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<sup>1</sup> We will use the term “currency union” to denote what in official European Union language is called the third stage of the European Monetary Union, EMU. It is common to use EMU to mean the currency union, but all European Union member states participate in the first, and some in the second, stage of the EMU and a subset of presently 13 countries also participates in the third stage, the currency union.

<sup>2</sup> See e.g. the survey of this literature by McKenzie (1999) and the ambitious study by IMF (2004).

European currency union. The studies surveyed by Baldwin (2006a) using data for the European currency union arrive at much smaller effects, ranging between a few to more than 30 percent.

Estimates of the euro's effect on trade are generally much greater than what would be expected from the empirical evidence on the effect of nominal exchange rate variability on trade and from the fact that the transaction costs for trade caused by having different currencies appear to be quite insignificant, probably only a fraction of one percent (European Commission, 1990; Calmfors et. al., 1997). Our study attempts to go some way towards explaining the surprisingly large euro effects on trade. One explanation is that the currency union reduces transactions costs and thereby increases operating profits sufficiently to cover the fixed costs of exporting, as in the model of trade on the intensive and extensive margin by Melitz (2003) and in particular the model of currency union formation by Baldwin and Taglioni (2004). Fixed costs may include costs for building distribution facilities and a distribution network, legal assistance, adapting the product to export markets and marketing. In other words, the currency union may stimulate trade on the extensive as well as the intensive margin. We provide evidence indicating that the euro has caused relatively larger increases in trade on the extensive than on the intensive margin.

Thus, we also contribute to recent empirical research to find determinants of trade on the intensive and extensive margin and to estimate their impact. The studies by Baldwin and Di Nino (2006), Felbermayr and Kohler (2006) and Helpman, Melitz and Rubinstein (2007) exploit the existence of zero trade between country pairs in cross-country or panel data to estimate effects on the extensive margin. Our contribution is to construct proxies for trade on the intensive and extensive margin using highly disaggregated trade data and to use these to estimate effects directly on the extensive margin.

A complementary explanation for the surprisingly large estimates may be found in increased international vertical specialization. The existence of small currency related transaction costs may not significantly affect the bilateral exports of a given product if the value-added is entirely created in the exporting country. If, however, the production chain is split into many different stages and across many countries and the creation of the currency union gives rise to increased international vertical specialization, we may find

that the sum of eliminated transactions costs adds up to a substantial cost reduction. A similar explanation of how relatively small tariff reductions can cause relatively large increases in world trade is given by Yi (2003). We provide two sets of estimates that indicate increased international vertical specialization caused by the euro. One set uses trade data disaggregated according to stages of processing and the other uses industry trade data.

Section 2 takes a preliminary look at unconditioned trade data and section 3 presents the model and data sources. Aggregate estimates of euro effects are presented in section 4, estimates on the intensive and extensive margin in section 5 and estimates on different stages of processing and industries in section 6. Section 7 summarizes.

## **2. Euro effects in the unconditioned trade data**

Our country sample consists of 20 countries, ten currency union members and ten outsiders, which form a comparison group. The number of countries that entered the currency union in 1999 was eleven, but we treat Belgium and Luxembourg as a single country since they were treated as such in trade statistics until 1998. Greece entered the currency union in 2001 and is not included because of potential problems in controlling for its late entry. The ten outsiders consist of almost all OECD countries with similar levels of development and per capita income as the currency union members.<sup>3</sup> The group consists of Denmark, Sweden and the United Kingdom, which are EU members, plus Australia, Canada, Japan, New Zealand, Norway, Switzerland and the United States.

Baldwin (2006a) argues that the comparison group should consist of only EU countries since this will control for effects of the Single Market and for EU harmonization of policies in general. The drawback is that with only three countries, the comparison is then with a mere 6 panels of data, whereas with ten countries the comparison is with 90 panels. We will present estimates with the large comparison group of ten outsider OECD countries as well as with a small comparison group of the three outsider EU countries throughout (with one exception), but it should be kept in mind that estimates using the small comparison group are especially susceptible to idiosyncratic effects.

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<sup>3</sup> Iceland was excluded because of its small size and atypical economy.

Our sample period is 1995-2005. The starting year was chosen for several reasons. First, Austria, Finland and Sweden became members of the EU in 1995. By starting in 1995, we do not have to control for the change in their status. Flam and Nordström (2003) show that estimates of euro effects on trade are robust in terms of significance to changes in the starting year between 1989 and 1995 and actually tend to increase with an earlier starting year.<sup>4</sup> Second, the Single Market officially started in 1993 but was implemented over a period of several years, both before and after 1993. By starting in 1995, we reduce the problem of controlling for Single Market effects. Nevertheless, we control for such effects in two ways, by controlling for whether the exporter, importer or both participate in the Single Market and by using two alternative control groups, one of which consists only of EU members. The latter controls for any additional effect that EU membership may have over and above participation in the Single Market.<sup>5</sup> Third, goods that are subjected to customs clearance in a Single Market country on their way to the final destination country are registered as trade both between the source and the intermediate country and between the intermediate and the final destination country starting in 1993. This has led to large increases in trade for countries with major ports serving trade between Europe and the rest of the world. By beginning the sample period in 1995, we do not need to control for the so-called Rotterdam effect, which was shown to be significant and substantial in Flam and Nordström (2003).

Figure 1 shows indexed time series for exports in constant prices for the period 1995-2005. We differentiate between three categories of exports: (1) between currency union members (exports within the eurozone), (2) from members to outsiders, and (3) from outsiders to members. All time series are relative to trade between the ten OECD countries in the sample that are not members of the currency union. The indices are

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<sup>4</sup> It should be noted, however, that Berger and Nitsch (2005) show that the euro effect on trade is reduced when the sample period is made much longer and becomes dwarfed and made insignificant by the time trend when the sample period is increased to 1948-2003.

<sup>5</sup> Norway is not a member of the EU but participates in the Single Market through the European Economic Area (EEA) agreement (as do Iceland and Liechtenstein). Switzerland has a free trade agreement with the EU that is not as far-reaching as the EEA agreement. Both agreements exempt trade in agricultural products.

unweighted averages of exports in each category. Thus, they are graphical representations of grouped, unconditioned and indexed panel data.<sup>6</sup>

[Figure 1]

Euro effects seem to be present for exports within the eurozone and from the eurozone to outsiders, but not for exports from outsiders to the eurozone. Naturally, we need to control for other factors that affect trade to be able to determine if euro effects are really present and how large they are. As will be seen, eyeball econometrics can only take us part of the way.

### 3. The gravity model and data sources

The gravity model has been extensively used to explain bilateral trade. It can be derived from the Ricardian model with a continuum of goods, the Heckscher-Ohlin model with more goods than factors and from the Chamberlin-Heckscher-Ohlin model with monopolistic competition and increasing returns to scale, see Anderson (1979), Deardorff (1998) and Helpman and Krugman (1985), respectively. It can also be derived from an aggregate expenditure function as in Baldwin (2006a).

The gravity model states that exports from country  $A$  to country  $B$  is a function of the product of the GDPs of countries  $A$  and  $B$  divided by the cost of exporting from  $A$  to  $B$ . This means that exports from  $A$  to  $B$  depend positively on the product of GDPs and negatively on the trade cost.

The trade cost is measured by geographical distance plus many other factors, such as border contiguity, shared language and trade policies. We let bilateral fixed effects capture all time invariant factors affecting one-way bilateral trade flows that are not explicitly controlled for. Anderson and van Wincoop (2001) have demonstrated that the relevant trade cost is the cost of exporting from  $A$  to  $B$ , *relative* to the cost of exporting from  $A$ 's competitors to  $B$ . This is accounted for by the fixed effects estimation.

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<sup>6</sup>The statistical analysis will treat all trade flows with equal weights. Weighting the observations by GDP would yield estimates for country groups. The two sets of estimates could differ substantially if the effects differ considerably across countries.

Separate euro effects for exports within the eurozone, exports from the eurozone to outsiders and exports from outsiders to the eurozone are identified by the use of dummy variables. We control for Single Market participation by the exporter, importer or both.

In most applications of the gravity model, the dependent variable is two-way and not one-way bilateral trade. If the dependent variable is two-way trade and trade is balanced, it may be of little consequence not to include the bilateral real exchange rate as an explanatory variable; a change in the real exchange rate will result in offsetting changes in exports and imports. However, real exchange rates with third countries should be included (but never are when bilateral real exchange is excluded). If the dependent variable is one-way trade, the volume of trade will depend on the bilateral real exchange rate as well as the real exchange rates between competing exporters and the importing country. We construct real exchange rate series by first constructing producer price indices expressed in U.S. dollars using producer price indices in national currencies and current nominal exchange rates. Next, we divide the producer price index in U.S. dollars of the exporting country by the corresponding index of the importing country to obtain the bilateral real exchange rate series. We expect exports to decrease when the value of the bilateral real exchange rate is increased. Competing countries' real exchange rates are constructed as their aggregate, export-weighted producer price index in U.S. dollars divided by the exporting country's producer price. We expect exports to increase when the value of competing countries' real exchange rate is increased.

The exporter's GDP is a measure of export supply capacity and the importer's GDP is a measure of import demand. We are wary of the possibility that euro effects will be confounded with business cycle effects, particularly since the sample period is relatively short, and therefore also control for cyclical variation in the elasticity of export supply and import demand over the business cycle. The export supply elasticity tends to be high when capacity utilization is low in the exporting country and the import elasticity to be high when capacity utilization is high in the importing country. We measure capacity utilization by the deviation from the trend of GDP. Data on GDP in constant prices expressed in U.S. dollars were taken from the OECD database

The common presumption that exchange rate volatility has a negative effect on trade has – as mentioned – little or no support in empirical research. We have not

included nominal exchange rate volatility as an explanatory variable in the reported regressions after finding that contemporaneous as well as lagged nominal exchange rate volatility have insignificant effects at the five-percent level.

The dependent variable in most regressions is exports in constant prices. Trade data in current U.S. dollars were taken from the UN Comtrade database accessed from the WITS portal.<sup>7</sup> They were deflated using national producer price indices converted into U.S. dollars at current exchange rates.

#### **4. Euro effects on aggregate trade**

All our estimates are difference-in-difference estimates. The estimates of the euro's effects on aggregate trade measure by how much the three categories of exports involving euro countries – exports within, from and to the eurozone, respectively – differ from exports between outside countries in a given year or period, relative to the starting year or period and controlling for a number of other factors that can affect trade.

The euro's effects on aggregate trade are estimated on exports that do not include energy raw materials and products (ISIC Rev. 3 industries 10-12 and 23). The reason for this exclusion is that we are unable to deflate the export data satisfactorily for these products. It is obvious that substantial price movements remain in the data after deflating with producer price indices, see section 6.

The first set of estimates is of annual differences, see Figure 2.<sup>8</sup> These will help us determine whether euro effects on trade exist at all.

[Figure 2]

Solid shading in Figure 2 denotes significant estimates and horizontal bars denote insignificant estimates, respectively. Estimates with the comparison group of ten OECD outsiders are all insignificant before 1999 and significant starting in 1999 (with one exception in 1999). Estimates with the three EU outsiders are insignificant until 2003

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<sup>7</sup> Data on Portugal's trade in 2005 were not yet available at the time of estimation. The number of observations is therefore reduced from 4 180 to 4 161 in regressions with the large comparison group and from 1 716 to 1 704 with the small comparison group.

<sup>8</sup> Numerical values can be found in Flam and Nordstrom (2006), table A1.



(with one exception) and significant only for trade within the euro zone from then onwards.

The existence of a break in the export time series in 1999 can be clearly seen in the estimates with the large comparison group. This is confirmed by testing for differences between estimates across years. Panel (a) in table A1 shows that all estimates for trade within the eurozone in 1999-2005 are significantly higher than the corresponding estimates for 1995-1998. A similar pattern can be seen for exports to the eurozone from outsiders and – to a lesser degree – for exports from the eurozone to outsiders. The set of estimates in panel (b) with the three EU outsiders as a benchmark also clearly indicates a break in 1999. Most estimates for trade within the eurozone are significantly higher in the euro period than before.

We conclude that the estimates in Figure 2 and the tests in Table A1 provide strong support for the existence of significant euro effects on trade. First, exports involving euro countries jump up in 1999. It is not surprising that substantial effects can be seen so early. The most important decisions on the currency union were taken by the European Council in May 1998, when it decided which countries would be allowed to join and fixed the exchange rates at which national currencies would be converted into euros on January 1, 1999. This meant that the exchange rates were in practice fixed already in May, since any changes between May and January could easily be hedged against. Second, there is a clear tendency that the euro effects are increasing over time, as should be expected.

We next estimate aggregate effects for the years 1999-2001 – which should be considered as a transition period – and for the years 2002-2005 – when the effects should have taken effect more fully as compared to 1995-1998. This amounts to comparing differences between averaged levels of trade involving euro countries before and after the introduction of the euro with the corresponding differences for trade between outsider countries, controlling for various other factors. Differences between averages over some years provide a more certain answer than differences between individual years to the question of interest: By how much has the euro increased trade?

Table 1 shows averaged estimates on aggregate trade (excluding energy raw materials and products):

[Table 1]

As can be seen, the euro's effects on trade are estimated to be very substantial. The largest effects are estimated for trade within the eurozone; it increased by 26 percent in 2002-2005 over 1995-1999 when compared to trade between the ten OECD outsider countries and by 21 percent when compared to trade between the three EU outsider countries. Substantial effects are also estimated for exports from and to the eurozone when compared to trade within the large comparison group. Exports from the eurozone to outsiders increased by 12 and exports from outsiders to euro countries by 13 percent. In contrast, exports from and to the eurozone did not increase significantly as compared to trade within the small comparison group (with one exception).

It should be noted in Table 1 that all the significant estimates involving GDP and real exchange rate variables have the expected signs and that most are highly significant. The elasticity of exports with respect to the importing country's GDP is about 1.2, which is consistent with the trend increase in the ratio of trade to GDP. The deviation from trend GDP in the importing country has the expected positive sign and is significant (not shown), indicating that imports depend positively on domestic capacity in a cyclical fashion. The exporting country's deviation from trend GDP has no significant effect, however. Real exchange rates have significant effects and expected signs (with the exception of the contemporaneous effect of competitors' real exchange rates in the destination country, which is insignificant and negative).

The results reported in Table 1 are remarkably robust to dropping various controls and dropping individual countries; see Flam and Nordström (2006, Table A3, A4 and A5). Estimates of euro effects tend to increase as controls are dropped, but remain highly significant. They are not much affected in size and significance as individual countries are left out, with two notable exceptions. Dropping Denmark raises all euro effects substantially, which indicates that the introduction of the euro caused Denmark to increase its trade with countries outside the currency union and decrease its trade with currency union countries in relative terms. Dropping the United Kingdom reduces the euro effects, which indicates that the euro caused the United Kingdom to increase its trade with currency union members and decrease its trade with other outside countries. The estimates with the small comparison group, consisting of the three EU outsiders,

Denmark, Sweden and United Kingdom, are the most sensitive, which is not surprising since dropping one country reduces the number of panels from six to only two in the comparison group.

The results give rise to two questions. First, the formation of the currency union has surprisingly large effects considering that the resource costs of currency exchange and hedging against changes in nominal exchange rates are calculated to be quite insignificant and considering that nominal exchange rate uncertainty has been found to have very small or no effects on trade. Second, it should be expected from customs union theory that eliminating trade costs between members of the currency union and leaving them intact between members and outsiders would divert members' trade with outsiders and make them trade more with each other. Our estimates say that the currency union has led to trade creation all around, between members as well as between members and outsiders.<sup>9</sup>

The surprisingly large currency union effects indicate that the effects of reducing nominal exchange rate volatility on the one hand and completely eliminating it by forming a currency union on the other are highly non-linear; the difference in uncertainty between even very small exchange rate volatility under a regime of flexible exchange rates and no nominal exchange rate volatility under a common currency is probably great in the minds of economic decision makers. Most of the empirical research on the trade effects of exchange rate uncertainty has dealt with changes at relatively high frequencies, month-to-month, quarter-to-quarter or year-to-year. Exchange rate uncertainty within a year can easily be hedged against at a low cost, but longer term uncertainty is much more costly or impossible to hedge against. If exporting decisions involve fixed costs and have time horizons of several years, exchange rate uncertainty could have much greater effects than what is generally found in empirical research. Relatively few studies have estimated the effects of exchange rate changes at low frequencies, but they tend to find significant negative trade effects (McKenzie, 1999).

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<sup>9</sup> It should be noted that the welfare effects for the importing country are entirely different in the case of a customs union as opposed to a currency union. In the former case, positive effects include reduced distortions and negative effects a lost tariff revenue. The creation of a customs union can be welfare decreasing. In the latter case, increases in the consumer surplus must outweigh losses in the producer surplus. Put differently, currency transaction costs are real and not administrative trade costs and their elimination results in gains from trade.

The increase in exports from outsiders to the eurozone could be explained by the existence of fixed costs in exporting. Assume that exporting requires local sales, storage and distribution facilities. Assume further that the low trade costs between countries forming the Single Market in combination with economies of scale make it profitable for outside exporters to have such facilities in just one country inside the Single Market and to incur the costs of shipping products to other countries within the Single Market through that country. Given these assumptions, outside exporters may benefit from the common currency to almost the same extent as exporters inside the Single Market. In addition, the reduction in trade costs caused by the common currency may make it profitable to incur the fixed costs of exporting and lead to new exports to the eurozone from outside countries. We provide evidence of strong effects on the external margin in section 5.

The unexpected increase in exports from the eurozone to outsiders could be explained by a lower cost of inputs for exporters. The common currency has reduced the cost of purchasing inputs from other countries belonging to the currency union and thereby made producers in the currency union more competitive. Yi (2003) shows that if the production process involves several stages located in different countries and the shipping of intermediate inputs across national borders, small trade costs can add up to a considerable share of the final cost. Section 6 provides evidence of the euro effects being concentrated to intermediate and final products and industries with highly processed products.

It should be added that the two proposed explanations for positive euro effects on trade between the eurozone and outside countries also help explain the positive effects on trade within the eurozone.

## **5. Euro effects on the intensive and extensive margins of trade**

We identify and estimate the euro's trade effects on the extensive margin by exploiting highly disaggregated trade data at the six-digit level of the Harmonized System (HS). The 5 015 product categories at the six-digit level multiplied by 380 bilateral one-way trade relations and a sample period of 11 years yield a dataset of nearly 21 million observations, including zeros. We attempt to estimate effects on the extensive margin in two ways, by

using the number of product categories in bilateral exports and by using a decomposition of product categories into exports on the intensive and extensive margin, respectively.

Estimates based on the number of product categories appear in Table 2.<sup>10</sup> The estimating equation is the same gravity equation that was used to estimate euro effects on aggregate trade, except that the volume of exports has been replaced by the number of product categories in bilateral exports.

[Table 2]

The euro is estimated to have increased the number of exported HS-6 product categories by about 6 percent within the eurozone and by about 4 percent between the eurozone and outsiders in both directions when the comparison group consists of the ten OECD outsiders. Estimates with the comparison group of three EU outsider countries are not significant.

Naturally, changes in the number of exported HS-6 product categories only approximate effects on the extensive margin of trade. Each product category often includes a number of different products, which means that changes can take place on the extensive margin that are not recorded as such as long as the product category has positive exports. Estimates using the number of product categories are therefore likely to underestimate effects on the extensive margin. Moreover, we cannot assess the quantitative importance of effects on the extensive margin relative to the intensive margin using the number of product categories. It is probably the case that the value per product category of new exports is, on average, considerably smaller than that of existing exports in a given year.

Our second approach to estimate euro effects on the extensive margin is better suited to give information about the relative importance of effects on the extensive margin. It is based on a decomposition of bilateral trade at the HS-6 level into trade on the intensive and extensive margins, respectively. We define the intensive margin to consist of HS-6 categories that are exported in each and every year in a given bilateral

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<sup>10</sup> These are OLS estimates. Exports in a given product category can be zero or positive. If observations on individual product categories were the dependent variable, we should use maximum likelihood estimates based on the Poisson distribution. The total number of product categories with positive bilateral exports is always positive, however.

one-way trade relation. There are approximately 1.9 million such panels. The remaining panels (except those with zero trade every year) are defined as exports on the extensive margin of trade. These panels consist of statistical product categories where no exports were registered in at least one of the years in our eleven-year sample period and where positive exports were registered in at least one year. Some statistical product categories cease to be exported after a certain year, some are exported intermittently during the sample period, and some are exported every year starting in some year after 1995. The value of extensive margin exports defined in this way as a share of total exports amounts to 10.6 percent of the exports within the eurozone, 15.5 percent of the exports from the eurozone, 17.7 percent of the exports to the eurozone and, on average, 17.4 percent of the exports between outside countries for the pre-currency union years, 1995-1998.

It must be pointed out that our definition of the intensive margin is probably too broad. The fact that many statistical product categories contain different products means that some changes on the extensive margin will be recorded as changes on the intensive margin. Our definition of the extensive margin is probably also too broad for the same reason. The heterogeneity of statistical product categories means that some changes that are recorded as changes on the extensive margin are changes on the intensive margin. Unfortunately, it is not possible to determine the direction of the overall bias.

The estimates on the intensive and extensive margins of trade are presented in Table 3.

[Table 3]

Practically all euro effects on the intensive and extensive margin of trade are highly significant when comparing with the ten OECD outsiders, whereas only estimates on trade within the eurozone are significant when comparing with the three EU outsiders. It is especially notable that effects on the extensive margin are estimated to be up to three times larger than those on the intensive margin for the larger comparison group. This indicates that the surprisingly large euro effects found for aggregate trade are to some extent explained by increased trade on the extensive margin.

## 6. Euro effects at different stages of processing and for different industries

We have put forward two possible explanations for the surprisingly large euro effects on aggregate trade. The first explanation centers on the existence of fixed start-up costs and fixed costs of exporting. Eliminating the costs of currency handling and the uncertainty of nominal exchange rates may make it worthwhile to start exporting by making operating profits sufficiently large to cover fixed costs. We have argued that this is also true for outsider exporters to the eurozone when they channel exports through one country in the eurozone. The second explanation centers on vertical specialization across countries. If such specialization is extensive, small reductions of trade costs between countries can add up to a substantial reduction in the cost of the final product. This may contribute to explain both the euro's effect on trade within the eurozone and its effect on exports from the eurozone. Our proposed explanation should be particularly relevant for intermediate inputs and final products, since they require relatively high fixed costs in the form of distribution and marketing and typically consist of a great number of inputs that are sourced from different countries, where the same component can cross national borders more than once in the process of production and assembly.

We have decomposed the trade data into three stages of processing, raw materials, semi-finished and finished product, following the Multilateral Trade Negotiation (MTN) classification of the World Trade Organization, and estimated the gravity equation for each category of products. The specification of the gravity equation has been modified by replacing the GDP of the exporter as a measure of supply capacity by the exporter's total exports of the product group.<sup>11</sup> Data on exports of product groups in current prices have been deflated by the exporter's producer price index. The appropriate procedure would have been to use a price index for each product group and stage of processing. Such price indices are not available, however.<sup>12</sup>

Table 4 reports our estimates for different stages of processing.

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<sup>11</sup> We note that the dependent variable is a component of total exports as an independent variable and can be correlated with it, which may give a simultaneity bias (but this is also the case for the specification with GDP, since trade is a component of GDP).

<sup>12</sup> Both value and physical quantity are reported at the HS six-digit level. The quantity data are, however, often missing and of poor quality. Our attempt to construct industry price indices produced implausible results and had to be abandoned.

[Table 4]

The euro estimates for semi-finished and finished products as compared to the ten OECD outsider countries have expected positive signs, are of similar magnitude and highly significant, whereas the estimates for raw materials are insignificant (with one exception). Moreover, the equation for raw materials has low explanatory power. The estimates with the smaller comparison group show a similar pattern, although fewer estimates are significant. It is clear that the inclusion of raw materials reduces the overall estimates and that the large and positive currency union effects for aggregate exports should be attributed to effects on trade in semi-finished and finished products. Hence, our estimates provide support for our proposed explanation that increased vertical specialization can explain part of the large euro effects on aggregate trade.

Table 5 reports euro effects for exports from individual industries at the ISIC two-digit level. The estimates reported in Table 5 were estimated with a modified gravity equation. Instead of using deviations from trend GDP as a measure of supply capacity, we used the total exports of the respective industry, and instead of using aggregate trade weights when calculating competitors' real exchange rates, we used weights based on the export shares of the respective industry and country.<sup>13</sup>

[Table 5]

Practically no effects are found in agriculture and related activities (01-05), mining and quarrying (10-14), and low-tech or raw materials based industries, such as food products (15-16), textiles and footwear (17-19), pulp and paper (21) or petroleum products (23). Significant, positive and large currency union effects are found exclusively (with one or two exceptions) for the chemical, metal product and engineering industries (24-36). Among the industries that stand out in terms of significant and large positive effects are pharmaceuticals (2423), rubber and plastic products (25), metals and fabricated metal products (27-28), machinery and equipment (29-33) and transport equipment (34-35). These are industries where the raw material component of the price is generally low

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<sup>13</sup> The industry trade data were compiled from HS six-digit level trade data using concordance tables available in the WITS portal.



because of the amount of processing involved and the aggregate producer price index should correspond approximately to the relevant product group price index.

The conclusion that can be drawn from the industry estimates is that the currency union effects on aggregate trade can be attributed to trade in highly processed products. The industries in question have relatively large shares of output and trade. Thus, industry estimates also lend support to our proposed explanation for surprisingly large euro effects on trade in terms of increased vertical specialization

The euro effects for raw materials and low-tech products are unclear. The high frequency of implausible point estimates for agriculture and other raw material based industries where prices are known to vary, such as for petroleum products, indicates that these estimates are much influenced by remaining price effects in the data after deflating with producer price indices. This is the reason for excluding energy raw materials and products in the aggregate trade data in constant prices.

## **7. Summary**

The euro's effects on trade are surprisingly large. We estimate that the average level of trade within the eurozone in 2002-2005 was 26 percent higher than the average level in 1995-1998, as compared to trade between ten OECD countries that are not members of the European currency union. Our estimate is based on a considerably longer period with the euro than previous estimates and should therefore be more certain. We also find that trade between the eurozone and the ten outsiders has increased by about 12 percent in both directions.

The surprisingly large effects of the euro and the finding that the euro has created instead of diverted trade between members of the currency union and outsiders call for an explanation. We propose two partial explanations, one in terms of substantial increases in trade on the extensive margin and the other in terms of increased vertical specialization. The first explanation is supported by evidence showing that the euro has caused an increase in the number of products being traded and evidence that increases on the extensive margin are proportionally greater than on the intensive margin of trade. The second explanation is supported by our finding that euro effects on aggregate trade are explained by effects on semi-finished and finished products, not on raw materials, and by

effects on industries with highly processed outputs, such as pharmaceuticals, machinery and transport equipment.

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Figure 1 Total real exports  
relative to exports between ten OECD outsiders

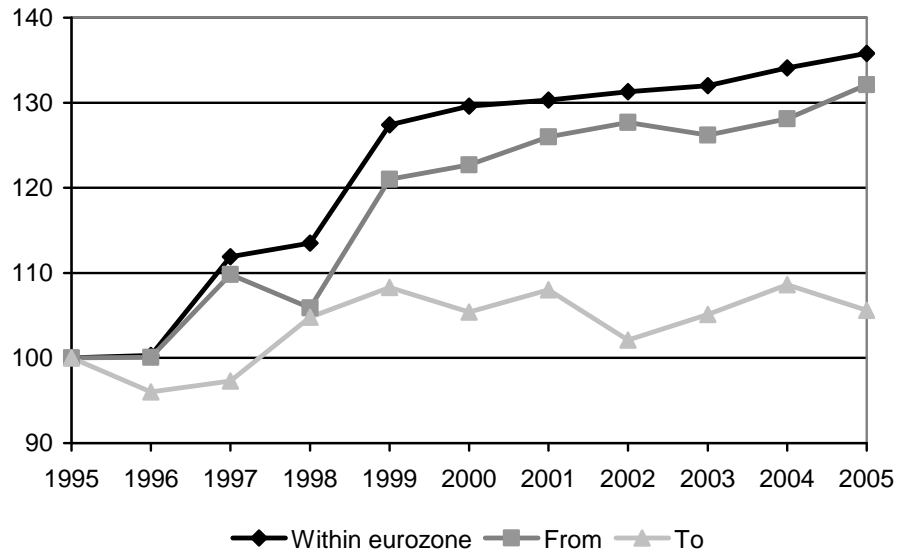
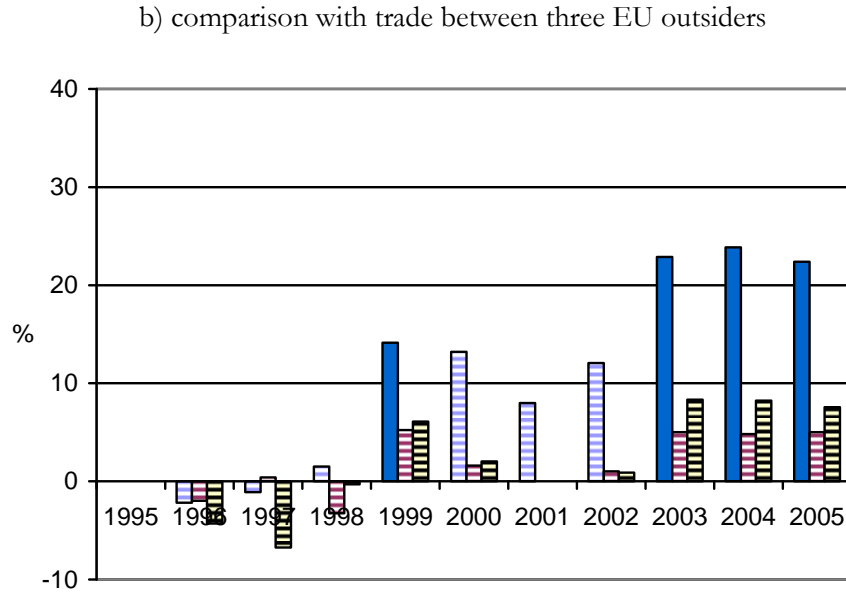
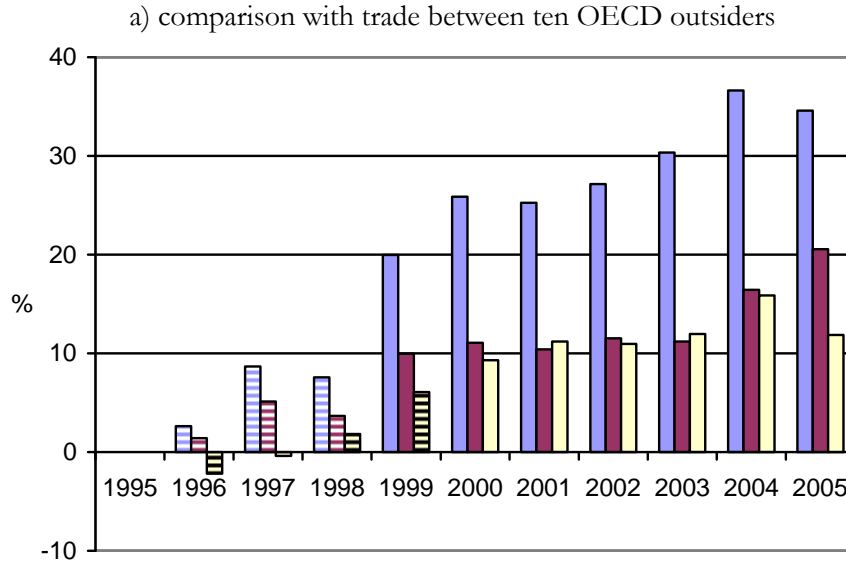


Figure 2 Aggregate annual estimates



■ Within euro zone ■ From ■ To

Solid shading pattern indicates significance at 10 % or less

Table 1 Aggregate averaged estimates

	Comparison group of ten OECD countries		Comparison group of three EU countries	
Trade within eurozone 1999-2001	0.165*** [0.023]	(18.0%)	0.114*** [0.032]	(12.1%)
Trade within eurozone 2002-2005	0.232*** [0.024]	(26.1%)	0.187*** [0.037]	(20.6%)
Exports from eurozone 1999-2001	0.074*** [0.020]	(7.7%)	0.032 [0.033]	(3.3%)
Exports from eurozone 2002-2005	0.113*** [0.022]	(12.0%)	0.052 [0.039]	(5.3%)
Exports to eurozone 1999-2001	0.085*** [0.025]	(8.9%)	0.053 [0.033]	(5.3%)
Exports to eurozone 2002-2005	0.120*** [0.026]	(12.8%)	0.086** [0.040]	(9.0%)
Real GDP of exporter	0.590*** [0.089]		0.603*** [0.117]	
Real GDP of importer	1.185*** [0.078]		1.198*** [0.104]	
Bilateral real exchange rate at $t$	-0.189*** [0.066]		-0.320*** [0.113]	
Competitors' real exchange rate at $t$	-0.297*** [0.094]		-0.161 [0.153]	
Bilateral real exchange rate at $t-1$	-0.605*** [0.067]		-0.595*** [0.108]	
Competitors' real exchange rate at $t-1$	0.392*** [0.091]		0.464*** [0.157]	
Observations	4161		1704	
Number of panels	380		156	
R-squared	0.53		0.65	

OLS, robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Country pair fixed effects. Controls for deviations from trend GDP and common year effects

Note: Percentage change =  $100 * [\exp(\text{estimate}) - 1]$



Table 2 Extensive margin estimates based on number of exported six-digit HS product categories

	Comparison group of ten OECD countries		Comparison group of three EU countries	
Trade within eurozone 1999-2001	0.031*** [0.009]	(3.1%)	-0.003 [0.009]	(-0.3%)
Trade within eurozone 2002-2005	0.056*** [0.011]	(5.8%)	0.006 [0.012]	(0.6%)
Exports from eurozone 1999-2001	0.031*** [0.008]	(3.1%)	-0.001 [0.010]	(-0.1%)
Exports from eurozone 2002-2005	0.040*** [0.009]	(4.1%)	-0.013 [0.012]	(-1.3%)
Exports to eurozone 1999-2001	0.014 [0.011]	(1.4%)	-0.007 [0.010]	(-0.7%)
Exports to eurozone 2002-2005	0.038*** [0.013]	(3.9%)	0.004 [0.013]	(0.4%)
Real GDP of exporter	0.237*** [0.035]		0.162*** [0.029]	
Real GDP of importer	0.412*** [0.038]		0.405*** [0.038]	
Bilateral real exchange rate at $t$	-0.764*** [0.028]		-0.826*** [0.036]	
Competitors' real exchange rate at $t$	0.661*** [0.042]		0.847*** [0.055]	
Bilateral real exchange rate at $t-1$	-0.120*** [0.026]		-0.211*** [0.032]	
Competitors' real exchange rate at $t-1$	0.120*** [0.039]		0.158*** [0.050]	
Observations	4161		1704	
Panels	380		156	
R-squared	0.74		0.91	

OLS, robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Country pair fixed effects. Controls for deviations from GDP trend, Single Market participation and common year effects

Table 3 Intensive and extensive margin estimates based on six-digit HS product categories

	Comparison group of ten OECD countries			Comparison group of three EU countries		
	Total	Intensive margin	Extensive margin	Total	Intensive margin	Extensive Margin
Trade within eurozone 1999-2001	0.165*** [0.023]	0.149*** [0.021]	0.210*** [0.059]	0.114*** [0.032]	0.128*** [0.034]	0.061 [0.083]
Trade within eurozone 2002-2005	0.232*** [0.024]	0.201*** [0.022]	0.324*** [0.057]	0.187*** [0.037]	0.184*** [0.038]	0.215** [0.090]
Exports from eurozone 1999-2001	0.074*** [0.020]	0.044** [0.018]	0.146*** [0.050]	0.032 [0.033]	0.028 [0.034]	0.055 [0.088]
Exports from eurozone 2002-2005	0.113*** [0.022]	0.072*** [0.020]	0.274*** [0.050]	0.052 [0.039]	0.031 [0.040]	0.228** [0.097]
Exports to eurozone 1999-2001	0.085*** [0.025]	0.078*** [0.021]	0.129** [0.057]	0.053 [0.033]	0.070** [0.035]	-0.028 [0.082]
Exports to eurozone 2002-2005	0.120*** [0.026]	0.090*** [0.024]	0.283*** [0.054]	0.086** [0.040]	0.087** [0.043]	0.117 [0.090]
Real GDP of exporter	0.590*** [0.089]	0.623*** [0.090]	0.330** [0.152]	0.603*** [0.117]	0.658*** [0.122]	0.027 [0.181]
Real GDP of importer	1.185*** [0.078]	1.054*** [0.084]	1.548*** [0.150]	1.198*** [0.104]	0.972*** [0.114]	1.689*** [0.196]
Bilateral real exchange rate at $t$	-0.189*** [0.066]	-0.164** [0.068]	-0.131 [0.149]	0.320*** [0.113]	-0.287** [0.116]	-0.949*** [0.253]
Competitors' real exchange rate at $t$	-0.297*** [0.094]	-0.244*** [0.091]	-0.357* [0.212]	-0.161 [0.153]	-0.317** [0.157]	0.850** [0.399]
Bilateral real exchange rate at $t-1$	-0.605*** [0.067]	-0.673*** [0.068]	-0.772*** [0.155]	0.595*** [0.108]	-0.578*** [0.112]	-0.398* [0.241]
Competitors' real exchange rate at $t-1$	0.392*** [0.091]	0.403*** [0.091]	0.637*** [0.221]	0.464*** [0.157]	0.419** [0.164]	0.375 [0.398]
Observations	4161	4161	4161	1704	1704	1704
Panels	380	380	380	156	156	156
R-squared	0.53	0.52	0.20	0.65	0.62	0.31

OLS, robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Country pair fixed effects. Controls for deviations from GDP trend, Single Market participation and common year effects

Table 4 Estimates on raw materials, semi-finished and finished products

(a) Comparison group of ten OECD countries

	Total	Raw materials	Inter-mediate	Finished products
Trade within eurozone 1999-2001	0.165*** [0.023]	0.061 [0.054]	0.212*** [0.040]	0.190*** [0.028]
Trade within eurozone 2002-2005	0.232*** [0.024]	0.001 [0.054]	0.246*** [0.039]	0.313*** [0.027]
Exports from eurozone 1999-2001	0.074*** [0.020]	0.083 [0.062]	0.099*** [0.033]	0.083*** [0.024]
Exports from eurozone 2002-2005	0.113*** [0.022]	0.049 [0.061]	0.101*** [0.032]	0.155*** [0.025]
Exports to eurozone 1999-2001	0.085*** [0.025]	-0.036 [0.054]	0.129*** [0.050]	0.092*** [0.030]
Exports to eurozone 2002-2005	0.120*** [0.026]	-0.084* [0.049]	0.189*** [0.048]	0.151*** [0.030]
Real GDP of exporter	0.590*** [0.089]	0.075 [0.163]	1.101*** [0.180]	0.609*** [0.091]
Real GDP of importer	1.185*** [0.078]	0.920*** [0.190]	0.993*** [0.151]	1.008*** [0.083]
Bilateral real exchange rate at $t$	-0.189*** [0.066]	-0.618*** [0.141]	-0.298* [0.156]	-0.092 [0.072]
Competitors' real exchange rate at $t$	-0.297*** [0.094]	0.359 [0.273]	0.274 [0.196]	-0.453*** [0.102]
Bilateral real exchange rate at $t-1$	-0.605*** [0.067]	-0.659*** [0.159]	-0.470*** [0.151]	-0.601*** [0.073]
Competitors' real exchange rate at $t-1$	0.392*** [0.091]	0.481** [0.242]	0.096 [0.195]	0.394*** [0.102]
Observations	4161	4161	4161	4161
Panels	380	380	380	380
R-squared	0.53	0.08	0.20	0.51

OLS, robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Country pair fixed effects. Controls for deviations from GDP trend, Single Market participation and common year effects

Table 5 Estimates for ISIC sectors and industries (comparison group of ten OECD countries)

	Total	01 - 05	10 - 12	13 - 14	15 - 16	17 - 19	20	21	22	23	24 - 2423	2423	25
Trade within eurozone 1999-2001	0.165*** [0.023]	0.062 [0.090]	-0.881** [0.432]	-0.112 [0.223]	0.069* [0.036]	0.011 [0.039]	0.289** [0.143]	0.165 [0.140]	0.094* [0.056]	0.045 [0.367]	0.048 [0.060]	0.265*** [0.074]	0.198*** [0.041]
Trade within eurozone 2002-2005	0.232*** [0.024]	0.092 [0.082]	0.772* [0.395]	0.010 [0.204]	0.050 [0.038]	0.027 [0.042]	0.422*** [0.134]	0.169 [0.129]	0.116** [0.055]	0.135 [0.334]	0.178*** [0.066]	0.586*** [0.079]	0.169*** [0.040]
Exports from eurozone 1999-2001	0.074*** [0.020]	0.002 [0.093]	-0.491 [0.393]	0.013 [0.222]	-0.009 [0.035]	-0.029 [0.035]	0.066 [0.136]	-0.016 [0.116]	0.119*** [0.046]	-0.318 [0.342]	-0.012 [0.047]	0.211*** [0.067]	0.122*** [0.039]
Exports from eurozone 2002-2005	0.113*** [0.022]	0.115 [0.089]	0.463 [0.393]	-0.021 [0.184]	-0.009 [0.035]	-0.083** [0.037]	0.307** [0.122]	-0.046 [0.108]	0.011 [0.049]	0.237 [0.322]	-0.027 [0.053]	0.386*** [0.071]	0.109*** [0.036]
Exports to eurozone 1999-2001	0.085*** [0.025]	-0.008 [0.070]	-0.106 [0.405]	-0.294 [0.263]	0.040 [0.037]	0.004 [0.045]	0.245 [0.178]	0.101 [0.186]	-0.072 [0.069]	-0.007 [0.362]	0.086 [0.084]	0.095 [0.088]	0.202*** [0.046]
Exports to eurozone 2002-2005	0.120*** [0.026]	-0.044 [0.066]	0.540 [0.368]	-0.165 [0.238]	-0.096** [0.039]	-0.086* [0.048]	0.343* [0.177]	0.121 [0.161]	-0.130** [0.061]	0.268 [0.341]	0.253*** [0.090]	0.345*** [0.095]	0.143*** [0.044]
Observations	4161	4161	4161	4161	4161	4161	4161	4161	4161	4161	4161	4161	4161
Panels	380	380	380	380	380	380	380	380	380	380	380	380	380
R-squared	0.53	0.07	0.03	0.02	0.38	0.20	0.11	0.08	0.14	0.31	0.15	0.35	0.25

	26	27	28	29	30	31	32	33	34	35	36
Trade within eurozone 1999-2001	0.158 [0.106]	0.286** [0.118]	0.181*** [0.040]	0.183*** [0.031]	0.097 [0.077]	0.135*** [0.046]	0.153** [0.073]	0.127*** [0.038]	0.221 [0.151]	0.221 [0.151]	0.143*** [0.055]
Trade within eurozone 2002-2005	0.254*** [0.091]	0.210* [0.113]	0.310*** [0.043]	0.253*** [0.031]	0.084 [0.073]	0.150*** [0.044]	0.351*** [0.078]	0.166*** [0.040]	0.482*** [0.147]	0.482*** [0.147]	0.151*** [0.054]
Exports from eurozone 1999-2001	0.121 [0.083]	0.209** [0.092]	0.081** [0.037]	0.029 [0.027]	-0.093 [0.068]	0.097** [0.048]	-0.019 [0.062]	0.036 [0.033]	0.148 [0.150]	0.148 [0.150]	0.089* [0.047]
Exports from eurozone 2002-2005	0.163** [0.077]	0.154* [0.086]	0.192*** [0.037]	0.084*** [0.028]	-0.015 [0.063]	0.111** [0.046]	-0.001 [0.068]	0.095*** [0.035]	0.489*** [0.157]	0.489*** [0.157]	0.105** [0.047]
Exports to eurozone 1999-2001	0.282* [0.152]	0.298* [0.165]	0.108*** [0.041]	0.145*** [0.036]	0.212*** [0.072]	0.059 [0.048]	0.129* [0.069]	0.017 [0.039]	0.189 [0.152]	0.189 [0.152]	0.144** [0.069]
Exports to eurozone 2002-2005	0.406*** [0.123]	0.445*** [0.155]	0.188*** [0.043]	0.131*** [0.034]	0.215*** [0.068]	0.153*** [0.046]	0.311*** [0.072]	0.021 [0.041]	0.490*** [0.134]	0.490*** [0.134]	0.238*** [0.065]
Observations	4161	4161	4161	4161	4161	4161	4161	4161	4161	4161	4161
Panels	380	380	380	380	380	380	380	380	380	380	380
R-squared	0.07	0.07	0.19	0.35	0.24	0.28	0.21	0.44	0.11	0.11	0.18

OLS, robust standard errors in brackets

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Country pair fixed effects. Controls for capacity (=total sector/industry exports), industry-specific competitors' real exchange rates, deviations from trend GDP and common year effects

## Legend:

01-05	Agriculture, hunting, forestry and fishing	26	Other non-metallic mineral products
10-12	Mining and quarrying except energy producing materials	27	Basic metals
15-16	Food products, beverages and tobacco	28	Fabricated metal products, except machinery and equipment
17-19	Textiles, textile products, leather and footwear	29	Machinery and equipment not elsewhere classified
20	Wood and products of wood, cork	30	Office, accounting and computing machinery
21	Pulp, paper and paper products	31	Electrical machinery and apparatus not elsewhere classified
22	Printing and publishing	32	Radio, television and communication equipment
23	Coke, refined petroleum products and nuclear fuel	33	Medical, precision and optical instruments
24(-2423)	Chemicals excluding pharmaceuticals	34	Motor vehicles, trailers and semi-trailers
2423	Pharmaceuticals	35	Other transport equipment
25	Rubber and plastic products	36	Furniture; manufacturing not elsewhere classified

Table A1 Tests of differences between annual coefficients

## a) Comparison group of ten OECD countries

		Within Eurozone									
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1996											
1997	1.32										
1998	1.21	0.02									
1999	17.02***	7.12***	10.48***								
2000	22.37***	11.24***	15.81***	0.99							
2001	23.92***	11.37***	16.69***	0.98	0.00						
2002	15.17***	6.31**	8.83***	0.01	1.11	1.15					
2003	32.60***	17.35***	23.99***	4.13**	0.99	1.27	4.46**				
2004	36.54***	21.67***	26.84***	7.52***	3.35*	3.82*	7.70**	1.02			
2005	30.29***	17.46***	21.32***	5.00**	1.96	2.23	5.21**	0.38	0.10		
		From Eurozone									
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1996											
1997	0.62										
1998	0.37	0.07									
1999	8.11***	2.74*	5.66**								
2000	6.27**	1.89	4.11**	0.12							
2001	5.67	1.57	3.53*	0.22	0.02						
2002	2.66	0.37	1.14	1.80	0.92	0.69					
2003	6.44**	1.97	4.15**	0.05	0.01	0.06	1.09				
2004	9.34**	4.34**	6.98***	0.82	1.31	1.55	3.47*	1.09			
2005	15.25***	7.93***	12.08***	3.11*	3.96**	4.36**	7.28***	3.52*	0.48		
		To Eurozone									
		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1996											
1997	0.12										
1998	0.61	0.20									
1999	3.88**	2.76*	1.41								
2000	4.97**	3.86**	2.35	0.28							
2001	7.16***	5.75**	3.98**	1.01	0.16						
2002	3.52*	2.45	1.24	0.00	0.22	0.84					
2003	8.47**	6.90***	4.88**	1.55	0.35	0.04	1.29				
2004	10.36***	8.80***	6.67***	3.15*	1.39	0.76	2.77*	0.50			
2005	5.35**	4.25**	2.89*	0.77	0.18	0.01	0.69	0.00	0.37		

## b) Comparison group of three EU countries

Within Eurozone										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1996										
1997	0.02									
1998	0.31	0.21								
1999	5.95**	7.59***	7.78***							
2000	4.27**	4.99**	4.38**	0.03						
2001	2.46	2.78*	2.27	2.34	0.97					
2002	2.65	2.73*	2.01	0.08	0.02	0.30				
2003	8.99***	10.22***	9.98***	1.74	1.67	5.42**	1.41			
2004	9.23***	10.46***	9.73***	1.87	1.79	5.16**	1.54	0.01		
2005	10.03***	11.68***	11.21***	1.84	1.70	5.80**	1.40	0.00	0.03	

From Eurozone										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1996										
1997	0.10									
1998	0.04	0.40								
1999	1.20	0.77	3.87**							
2000	0.25	0.03	0.86	0.59						
2001	0.03	0.06	0.28	2.70	0.28					
2002	0.12	0.01	0.37	0.37	0.01	0.08				
2003	0.77	0.41	1.77	0.00	0.27	1.03	0.23			
2004	0.65	0.33	1.41	0.00	0.20	0.78	0.19	0.00		
2005	0.84	0.45	1.94	0.00	0.30	1.13	0.25	0.00	0.00	

To Eurozone										
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1996										
1997	0.12									
1998	0.32	1.20								
1999	2.33	5.60**	1.64							
2000	0.75	2.09	0.17	0.59						
2001	0.40	1.56	0.00	2.28	0.18					
2002	0.36	1.00	0.02	0.53	0.02	0.02				
2003	2.37	4.52**	1.61	0.13	0.80	1.89	0.76			
2004	1.99	3.69*	1.24	0.09	0.61	1.38	0.63	0.00		
2005	1.88	3.65*	1.18	0.05	0.54	1.35	0.56	0.01	0.00	

F-values of Wald test

\* significant at 10 %, \*\* significant at 5 %, \*\*\* significant at 1 %



